LLNL Environmental Restoration Division Standard Operating Procedure	TITLE: Disposal of Investigation-Derived Wastes (Drill Cuttings, Core Samples, and Drilling Mud)
APPROVAL Date _____ _____ Environmental Chemistry and Biology Group Leader	PREPARERS: T. Carlsen, J. Gardner*, S. Gregory, J. Hoffman*, and S. Nelson* REVIEWERS: R. Bainer, L. Berg, V. Dibley, and J. Duarte, J. Greci,
APPROVAL Date _____ _____ Division Leader CONCURRENCE Date _____ _____ QA Implementation Coordinator	PROCEDURE NUMBER: ERD SOP-1.8 REVISION: 2 EFFECTIVE DATE: December 1, 1995 Page 1 of 20

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1.0 PURPOSE

To ensure that investigation-derived drill cuttings, unused core samples, and drilling mud/initial muddy development water from Site 300 and Livermore Site are properly disposed of in a manner consistent with the protection of human health and the environment using the guidance provided by Reference 3.12 below. This guidance states that "the management of investigation-derived wastes (IDW) must ensure protection of human health and the environment and comply with certain applicable or relevant and appropriate requirements (ARARs)." The guidance further states that "as a general rule, it will be necessary to use best professional judgment, in light of the site-specific conditions, to determine whether an option is protective of human health and the environment." The following SOP reflects LLNL's evaluation of ARARs and its best professional judgment concerning the management of investigation-derived drill cuttings, core samples, and drilling mud.

2.0 APPLICABILITY

The following procedure and information is applicable to all activities which can generate investigation-derived wastes (i.e., drill cuttings, core samples, and drilling mud/initial muddy development water). The following sections describe the handling, screening and disposal of drilling wastes containing: volatile organic compounds (VOCs), petroleum products, metals,

tritium, and high-explosive (HE) compounds. Prior to the initiation of a given drilling project, the Drilling Supervisor (DS) and the Environmental Chemistry and Biology Group Leader (ECBGL) should be consulted concerning interim handling of the drilling wastes. Prior to the disposal of waste from a given drilling project containing a combination of any of the above contaminants, or with any other detectable contaminants, include the Drilling Coordinator (DC), Drilling Geologist (DG), ECBGL, Field Coordinator (FC), appropriate Environmental Analyst (EA), and the appropriate Site 300/Livermore Site DS, should be informed of the final disposition of the waste. All personnel involved in such activities shall review this procedure prior to participation.

3.0 REFERENCES

3.1 10 CFR 61.55.8-40-112 and 8-40-205 BAAQMD, Bay Area Air Quality Management District (Revised draft 1/11/89) Regulation 8, Organic Compounds Rule 40 Aeration of Contaminated Soil and Removal of Underground Storage Tanks.

3.2 California Regional Water Quality Control Board–Central Valley Region (1992), *Water Quality Control Plan (Basin Plan) For the California Regional Water Quality Control Board Central Valley Region*, Second Edition.

3.3 California Regional Water Quality Control Board–San Francisco Bay Region (1982), *Water Quality Control Plan (Basin Plan), San Francisco Bay Basin, State of California*, Oakland, CA.

3.4 Carlsen, T. M., Ed. (1991), *Lawrence Livermore National Laboratory Site 300 Environmental Investigations Quarterly, April-June 1991*, Lawrence Livermore National Laboratory, Livermore Calif. (UCAR-10194-91-2).

3.5 Crow and Lamarre (1990), *Remedial Investigation of the High-Explosives (HE) Process Area*, Lawrence Livermore National Laboratory Site 300 (UCID-21920).

3.6 Foxboro Company (1985), Instruction Manual Foxboro Model 128 Century Organic Vapor Analyzer, M1 61 1-132.

3.7 Hoffman, F. and M. D. Dresen (1990), "A Method to Evaluate the Vertical Distribution of VOCs in Ground Water in a Single Borehole," *Ground Water Monitoring Review*, Spring 1990, 10(2), 95-100.

3.8 Isherwood, W. F. (1994), letter to Vincent Chrisitian, California Regional Quality Control Board, San Francisco Bay Region (2), regarding using soils concerning trace levels of contaminants as fill, dated November 18, 1994.

3.9 Jackson, C. S. (1995), letter to Vincent Chrisitian, California Regional Quality Control Board, San Francisco Bay Region (2), regarding beneficial reuse of soils containing metals slightly exceeding background values, dated July 24, 1995.

3.10 Marshack, J. B. (1989), *The Designated Level Methodology for Waste Classification and Cleanup Determination*, California Regional Water Quality Control Board—Central Valley Region.

3.11 409.9 SJCAPCD, San Joaquin County Air Pollution Control District (1988), *RULE 409.9 Volatile Organic Compound Emissions from Decontamination of Soil* (Adopted Nov. 29, 1988, Effective July 1, 1989).

3.12 State of California Leaking Underground Fuel Tank Task Force (1988), *Leaking Underground Fuel Tank (LUFT) Field Manual.*

3.13 Title 22, California Code of Regulations, Chapter 11, Section 66261.24 (Register 95, No. 42; 10-20-95) and Appendix 11 (Register 95, No. 21; 5-26-95).

3.14 Title 22, California Code of Regulations, Chapter 18, Section 66268.40 (Register 95, Nos. 7-8; 2-24-95) and (Register 92, Nos. 15-17; 4-24-92).

3.15 U.S. Environmental Protection Agency (EPA) (1991), *Guide to Management of Investigation-Derived Wastes*, U.S. EPA, Office of Solid Waste and Emergency Response, Publication 9345.3-03FS, October 1991.

4.0 DEFINITIONS

4.1 Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs are legally applicable or relevant and appropriate requirements, as used in Comprehensive Environmental Response, Compensation and Liability Act of 1980.

4.2 Flame Ionization Detector (FID) Meter

A portable field instrument used for the quantification of hydrocarbon compounds ranging from methane to aromatic compounds such as benzene. The FID meter works by ionizing molecules by a hydrogen flame, and measuring the current generated. The measured current is directly proportional to the number of ionized molecules, and so the concentration of the compound(s) can be determined. As the organic compounds burn, positively charged, carbon-containing ions are produced and are collected by a negatively charged collecting electrode. The current produced is directly proportional to the compound concentration. Due to the use of the flame, this instrument is less sensitive to moisture in the vapor stream than the photoionization detector. The FID meter is usually calibrated against methane, but can also be calibrated using other compounds.

4.3 Freeboard

The amount of space left unfilled in a hole or depression.

4.4 Halocarbon

A carbon-based compound containing one or more halogen atoms (fluorine, chlorine or bromine).

4.5 Headspace

The space within a container which is composed of air above a solid or liquid.

4.6 Investigation-Derived Wastes (IDW)

Investigation-Derived Wastes (IDW) are drill cuttings, core samples, and/or drilling mud/initial muddy development water, which are typically produced during subsurface investigations (i.e., the drilling of boreholes and the installation/development of wells). Drill cuttings and core samples are produced during hand auguring, mechanized hollow-stem auguring, and rotary drilling activities. Most core samples are submitted to analytical laboratories or are permanently stored on site in core boxes for future reference. Cores not used in either manner are incorporated into the drill cuttings or drilling mud. During mud-rotary drilling, formation cuttings are entrained in the drilling mud, and initial development will produce drilling mud mixed with formation ground water and fines. Air-mist rotary drill cuttings are circulated to the surface with compressed air.

4.7 Photoionization Detector (PID) Meter

A portable field instrument used to quantify purgeable aromatic compounds (i.e., benzene, toluene, and xylene in vapors, but is also useful for other hydrocarbons). The PID meter is most effective on unsaturated compounds containing double bonds. The PID meter works by directing ultraviolet (UV) light onto the molecules, ionizing them, and measuring the current generated. The measured current is directly proportional to the number of ionized molecules, so the concentration of the compound(s) can be determined. It is usually calibrated against isobutylene or benzene, but can be calibrated using a compound of interest such as trichloroethene (TCE). However, this device is not compound specific and these measurements represent an aggregate concentration of all compounds that are ionized and detected. This device is sensitive to moisture, therefore moist vapor streams should be analyzed using an alternate instrument such as an FID meter.

4.8 Practical Quantitation Limit (PQL)

The PQL is approximately five times the method detection limit and represents a practical and routinely achievable detection limit with a relatively good certainty that any reported value is reliable.

4.9 Soluble Threshold Limit Concentration (STLC)

A State of California method and value that can be used to determine if a waste is hazardous. Specifically, the STLC is the concentration of a solubilized and extractable bioaccumulative or persistent toxic substance as determined by the California Assessment Manual, Waste Extraction Test (CAM WET), which if equaled or exceeded in a waste or waste extract, renders the waste hazardous.

4.10 Toxicity Characteristic Leaching Procedure (TCLP)

The TCLP is a U.S. Environmental Protection Agency (USEPA) analytical method designed to determine the mobility of both organics and inorganics in liquid, solid, and multiphase waste. It is used to determine applicability of Land Ban regulations to a waste.

4.11 Organic Vapor Meter (OVM)

The OVM is a broad category of instruments which can determine total volatile organic compound concentrations in vapor. FID and PID meters are commonly referred to as OVMs.

5.0 RESPONSIBILITIES

Note: The following responsibilities (Sections 5.1–5.5) are listed by the appropriate level of authority to ensure that proper representation for all procedures and regulations related to this SOP are met.

5.1 Division Leader

The Division Leader's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Hydrogeologic Group Leader (HGL)

The HGL's responsibility is to ensure that proper procedures are followed for activities (i.e., drilling, borehole logging and sampling, monitor well installations and development) and to oversee the disposal of all investigation derived wastes.

5.3 Drilling Supervisor (DS)

The DS plans and coordinates all drilling related activities, ensures that all drilling related activities are performed safely and efficiently (using the proper procedures), and that the data generated from these activities are valuable and representative of the true geologic or physical conditions within the borehole. Such activities may include operation of logging equipment, soil sampling, well installation, and development. The DS is also responsible for:

5.3.1 Coordination of the drilling contractor schedules and equipment needs:

- Coordinate the schedules of multiple drill rigs with the drilling contractor.
- Provide the Work Plan to the drilling contractor and answer questions.
- Negotiate the arrival/start date and drill type.
- Monitor the progress of the drilling and anticipate changes in equipment needs (e.g., auger rig, air-mist rig, mud-rotary rig).

5.4 Drilling Coordinator (DC)

5.4.1 The DC provides the interface between the DS and the field activities including:

- Oversight of the Drilling Geologist (DG) and field activities.
- Coordinate the DG's work load.
- Obtain the necessary equipment, supplies, and release numbers from the Technical Release Representative (TRR) for the drilling contractor.
- Provide guidance and training.
- Inform the DG about procedural changes in areas related to drilling (e.g., changes in sampling requests, cuttings disposal issues, new forms, etc.).

- Provide technical input to the DG and Study Area Leader (SAL)/Facility Task Leader (FTL).
- Review borehole and geophysical logs.
- Monitor drilling progress on a daily basis.
- Interact with the Quality Assurance (QA)/Quality Control (QC) officer on drilling and soil sampling issues.
- Estimate the contaminants likely to be present, and the quantity of drilling spoils that may be generated.

5.4.2 During the startup of a new drilling phase, the DS works with the DC and SAL/FTL to:

- Create and finalize all related drilling documents (i.e., the Work Plan and Sampling Plan).
- Work with the SAL/FTL to establish drilling locations, schedules, and budgets for each well.
- Determine the protective equipment necessary for personnel in the field.
- Make well completion decisions and specify the well construction details from the SAL/FTL and Hydrogeologic Group Leader (HGL) input.
- Act as the liaison between the SAL/FTL and the DG.
- Coordinates all necessary biological/archeological surveys prior to drilling. Results of the surveys should be forwarded to the SAL/FTL and Environmental Chemistry and Biological Group Leader (ECBGL).

5.5 Drilling Geologist (DG)

The DG's responsibility is to ensure that drilling activities are carried out according to the specifications designated in the Work Plan, Sampling Plan, Site Safety Plan (SSP), Operation Safety Procedure (OSP), and Standard Operating Procedure (SOP). Additionally, the DG must oversee and document all aspects of the drilling/field investigation, including lithologic and geophysical data, well completion and development specifications, activities of the drillers, sampling and workspace monitoring details. The DG is also responsible for:

5.5.1 Site Preparation and Supply Ordering. The DG must:

- Review the Work Plan prepared by the SAL/FTL and DC, and discuss any questions.
- Assemble all necessary materials, including personal protective equipment (PPE).
- Supply tracking and ordering requests.
- Confirm that all necessary security arrangements have been made to permit site access (e.g., schedule escorts, notify the building coordinator of planned activities, arrange for opening of locked gates).
- Confirm that utility locator and mud pit excavations (if necessary) have been arranged with the field personnel.

- Discuss LLNL site planning requirements and utility lines with field personnel and drillers before drilling begins.

5.5.2 Site Safety

- Supply the SSP, OSP, and SOPs to all workers who enter the drill site.
- Monitor and record work space conditions with appropriate monitoring equipment (including FID, PID, etc.) during drilling activity.
- Confirm that appropriate fencing, warning signs, barricades, animal exit ramps (for mud pit), borehole cover and protection are in place.
- Discontinue work and contact the DC if chemical or physical hazards are encountered.

5.5.3 Field Activities

- Coordinate schedules/actions with field personnel.
- Research site hydrogeology to estimate key parameters (e.g., sample target zones, hydrostratigraphic unit depths and thicknesses, and types of contaminants).
- Obtain a field logbook from the Data Management Group (DMG).
- Calibrate and record calibration information for all monitoring equipment.
- Confirm all sample naming conventions with DMG.
- Collect and document samples.
- Handle all changes and corrections to chain-of-custody (CoC) forms and/or analytical requests.
- Inform the DC, SAL/FTLs, and DMG of any sampling or sampling documentation irregularities.
- Report any deviations from the SSPs, OSPs, or SOPs to the QA/QC Officer.
- If SOPs are violated, a nonconformance report is to be completed and submitted to the QA/QC officer.
- Report missed turnaround times for analytical sample results to QA/QC Officer.
- Confirm that drilling waste analytical results are consistent with the chosen disposal method.
- Decontaminate all sampling equipment.
- Provide frequent updates and documentation of field activities to the DC, HGL, and SAL/FTL.

5.6 Environmental Chemistry and Biology Group Leader (ECBGL)

The ECBGL's responsibility is to provide biological or chemical information and expertise (i.e., biological surveys, water supplies, chemical field instruments, etc.).

5.7 Field Personnel

The field personnel's responsibilities are to conduct all ERD field work that complies with all established operational and safety procedures, and to inform the HGL when the procedures are inappropriate.

Activities the field personnel are responsible to perform (but are not limited to) are to:

- Collect, store, and ship borehole samples to analytical laboratories.
- Drill, complete wells, log boreholes, and properly develop wells to allow the highest yield and the highest quality samples.
- Communicate the performance of development activities to the HGL and DC to allow for modification of the development methods to improve well yield.

5.8 Site Safety Officer (SSO)

The SSO's responsibility is to ensure the safety of ERD's ongoing operations and facilities and work performed. The SSO's responsibility is to receive the details of potential hazards and procedures for all field activities. The SSO directs this information to the LLNL Hazards Control Department to determine if a new Operational Safety Procedure (OSP) is required, thus assuring that an existing OSP addresses all ES&H issues for each operation.

5.9 Study Area Leaders (SAL)/Facility Task Leader (FTL)

The SAL/FTL are responsible for the overall investigation, planning, assessment, and remediation within a study area.

5.10 Technical Release Representative (TRR)

The TRR is responsible for the acquisition and administration of blanket contract releases for the procurement of goods and services. The TRR has the authority to obligate LLNL for payment of goods and services, delegated by the LLNL Business Manager through the LLNL Procurement Department.

5.11 Treatment Facility Hydrogeologist (TFH)

The TFH is responsible for helping the SAL/FTL determine borehole location and target zone for completion.

6.0 PROCEDURE

6.1 Chemical Analysis

6.1.1 Chemical analyses on drilling wastes are usually performed in areas of known or suspected contamination or in previously unexplored areas. Drilling wastes from areas with an extensive historical record of sampling and chemical analyses that detected no chemical contamination are generally not chemically analyzed.

6.2 ARARs

6.2.1 According to available guidance (EPA, 1991), the EPA expects soil IDW to be returned to the source if short-term protectiveness of human health and the environment is not an issue. Therefore, in the long term, the IDWs that could pose a risk to human health and the environment will be addressed by the final action. Unfortunately, it is often impossible to return drill cuttings and cores back to the borehole when the borehole is completed as a well. Thus, a review of

ARARs was conducted to determine the best disposal methods for such IDW. Also, State law allows Regional Boards to waive waste discharge requirements (WDRs) for a specific discharge or types of discharges where it is not against the public interest [California Regional Water Quality Control Board (RWQCB) 1992]. As listed in Table IV-1 of the Central Valley Region Basin Plan, drilling mud is one type of discharge which has a WDR waiver. The specific procedures related to drilling mud are discussed later in this SOP.

6.2.2 Attachment A lists ARARs that may be applicable to drill cuttings, core samples, and drilling mud. Attachment A also describes actions taken to comply with substantive portions of each regulation, as required by EPA, 1991. As a result of our review of these ARARs, we feel the best management practices are observed when drill cuttings are disposed of in the immediate vicinity of the drilling activity. However, due to programmatic constraints at the Livermore Site, it is often not possible to dispose of drill cuttings in the vicinity of the boreholes. Therefore, drill cuttings are disposed of at the designated Drilling Cuttings/Laydown Area on site.

6.3 Disposal Criteria

The disposal criteria in this procedure were developed to ensure that no wastes, which are above the Resource Conservation and Recovery Act (RCRA) hazardous waste levels, or waste with specified levels (described below) of HE or radioactive contaminants are disposed of on the ground surface near the borehole. When necessary, LLNL Hazardous Waste Management Division (HWM) will dispose of investigation-derived hazardous wastes.

6.4 Office Preparation

6.4.1 Prior to the start of any subsurface investigations projects, the DS, EA, ECBGL, DC, DG, FC, HGL, and SSO shall discuss the types and concentrations of contaminants that may be encountered. This information serves to anticipate the proper disposal method for the drill cuttings, unused core samples, and/or drilling mud.

6.4.2 Estimate the total volume of drilling spoils which will be generated. This is especially important for drilling mud, since an appropriate size pit must be excavated if the drilling location is suitable to contain mud at Site 300 and enough capacity is available for transporting mud at the Livermore Site.

6.4.3 <u>If drilling off site:</u>

Drilling spoils at Site 300, may be hauled for disposal to a designated area on site determined by the Site 300 EA. The need for removing drilling spoils from the drilling area is determined during consultation with the EA and Site Manager.

At the Livermore Site, contact the Facility and Field Technical Support Team Leader or his designee to determine disposal locations. Usually, drilling spoils will be disposed of at the Drill Cuttings/Laydown Area.

6.4.4 Obtain field PID or FID meters, calibrate standards, necessary hydrogen fuel, and ensure they are operating properly and battery is charged.

6.4.5 Obtain the level of personal protection equipment (PPE) as required by Site 300's Site Specific Safety Plan (SSSP) and Livermore's Site Safety Plan (SSP) when

handling these wastes, unless augmented by a site-specific Operational Safety Procedure (OSP). Questions concerning PPE should be directed to the LLNL Hazards Control Department and is referenced in ("Drilling", OSPs, L-50.14 and 0-121).

6.4.6 This step is necessary only for mud-rotary drilling:

For Site 300 drilling, obtain the most current water quality analyses for the water-supply well that will supply the makeup water.

For Livermore Site drilling, obtain the most current water quality analyses for the fire hydrant that will supply the makeup water.

6.4.7 For mud-rotary drilling only:

When no historical VOC data exists for the water-supply source that will supply the make-up water for the drilling mud, the DG shall collect a sample and submit it to the analytical laboratory for a water quality analysis (Method EPA 601). The DG shall add up the reported concentrations for the trihalomethanes (THMs) (chloroform, biomodichloromethane, chloromethane, chlorodibromomethane, and bromoform) from the sample results. This total shall be recorded on the field log and appropriate logbook as the Water-Supply Source Water Quality Analysis Total Trihalomethane Concentration. The DG also has the option of obtaining a field measurement of THMs by screening the water samples from the water-supply source using an FID or PID meter. This field reading shall be known as the Background Value and shall be recorded on the field log and appropriate logbook. Field derived screening of drilling mud with concentrations equal to or below the Background Value will be attributed solely to the presence of THMs from the make-up water.

6.5 Field Preparation

6.5.1 Calibrate PID or FID meter according to manufacture's calibration instructions daily using calibration standards. The results of the calibration as well as the calibration date, time, and instrument identification should be recorded in the field logbook and a daily field report form. Additionally, a tag should be taped to the instrument with date and initials of the person who last calibrated the unit.

6.5.2 Site 300

Determine location for placement of drill cuttings or installation of pit to contain drilling mud. Drill cuttings and mud pit should not be visible from a road. If drilling is performed on a hill, actions must be taken to ensure no stream of water or drilling mud will flow down the hillside. If drill cuttings or mud cannot be hidden from view due to the proposed drilling location, the DC should discuss the situation with the EA and/or the FC, who should then consult the Site Manager.

6.6 Handling of Drilling Waste

For Site 300, direct all drilling waste generated from air-mist or mud-rotary drilling into a mud pit adjacent to the drilling site. When drilling off site near Site 300 and/or Livermore Site, the drilling mud must be kept in a container until transported on site for disposal.

Drill cuttings from auger drilling generated on site at Site 300 and the Livermore Site, may be placed on the ground on plastic or kept in containers until transported on site for disposal. Drill cuttings generated off site at Site 300 and the Livermore Site must be kept in containers until transported on site for disposal. The proper methods for drilling waste disposal depends on the waste contaminants and their concentrations. The type of analyses conducted on drilling wastes is determined from historical data. If no historical data is available, a variety of analyses, as determined by the ECBGL, FC, SAL/FTL, and/or DC, should be used to ensure that analyses for all potential contaminants will be performed. If contaminant type(s) or concentrations are suspected or determined in drilling spoils to be hazardous, the drilling wastes should be segregated by depth to isolate the spoils from the contaminated zones. These spoils should be placed on plastic or in hazardous waste drums. Final disposal is discussed in Section 6.8. If cuttings or drilling mud are significantly above the disposal criteria during drilling and field screening, the wastes shall be handled as stated above.

6.7 Screening of Drilling Waste

6.7.1 Screening Frequency

Screen core samples or cuttings using a PID or FID meter approximately every 5 ft of drilling, or at a reduced permeability interface where there is a likelihood of contaminant accumulation. If VOC contamination of the drilling spoils is encountered, the spoils should be segregated from the previously clean spoils (as described above), and the frequency of screening should be increased as directed by the DG. When using mud-rotary drilling techniques, aliquots of drilling mud shall be collected from the mud tank or trailer for field PID or FID meter screening prior to disposal. Each load of the mud shall be screened separately. At drilling sites where contaminants are known or suspected, samples are usually submitted for laboratory analysis for hydrogeological investigation purposes at these same intervals of concern. However, these results can also be used for disposal decisions. If core sample collection is not possible, collect one sample of drill cuttings or drilling mud from the borehole or mud trough. This sample should be from the depth interval, which is expected to exhibit the highest contaminant concentrations.

6.7.2 Screening Methods

A. VOCs

Field screening by head space analysis is used to check drilling spoils to determine disposal protocol. If the results obtained by head space analysis approaches 10 $ppm_{v/v}$, cuttings should immediately be segregated and handled as described in Section 6.6. Samples of the spoils should also be collected and submitted for laboratory analysis. Only certified analytical laboratory results may be used to confirm if the drilling spoils actually should be classified as hazardous waste.

1. Collect enough drilling waste (drilling mud or cuttings) to fill two 40 ml vials (or equivalent containers).
2. Immediately empty the two vials into a new, clean plastic bag. Capture approximately 1 liter of air in the bag before sealing. Shake the bag well. Then place the bag on a stationary surface (in the sun, if possible) to allow the headspace to come into equilibrium with the waste. The length of time the headspace is allowed to equilibrate will depend on ambient

temperature and humidity conditions; 2 minutes if temperature is >90° F, at least 5 minutes if >70° F, 10 minutes if 70° to 50° F, and 15 minutes if <50° F. In extremely hot conditions, if the bag is allowed to sit too long, a buildup of water vapor in the bag may affect a PIDs performance. An FID should not have any negative effects from water vapor.

3. Insert the tip of the OVM probe into the headspace of the plastic bag by piercing it with the probe. Avoid making contact with mud, soil, or water with the instrument tip to prevent these materials from being sucked into the instrument.
4. Read the meters' display to obtain a total VOC concentration of the headspace in parts per million on a volume to volume basis ($ppm_{v/v}$).
5. Record this reading on the borehole well construction form, and refer to the criteria below for disposal.

B. Radiologicals

In areas at Site 300 and the Livermore Site where there is suspected radiological contamination the Environmental Safety and Health [ES&H] Team 1, Site 300 or Team 4, the Livermore Site will be notified prior to drilling. The drill cuttings shall be surveyed as directed by Team 1 or Team 4. When the screening method detects activity two times the background level, the SAL will determine the necessary number of samples and analyses to be performed by an analytical laboratory.

6.8 Disposal of Drilling Waste

6.8.1 Volatile Organic Compound Investigations

TCE is the predominant purgeable halocarbon contaminant at Site 300 and the Livermore Site. The U.S. EPA TCLP maximum contaminant concentration of 0.5 mg/L in the resulting extract has been selected for our disposal criteria. Using the TCLP, soluble constituents in a soil sample are extracted using a 20:1 dilution (by weight). In order to insure that the extract concentration of TCE does not exceed 0.5 mg/L, a value of 10 mg/kg is the disposal criteria above which the soil will be dealt with in a manner to ensure maximum environmental protection as described below.

Drill cuttings are initially screened for the presence of VOCs using a field headspace screening method as described above. An OVM is used in the screening mode to obtain a total hydrocarbon concentration in the headspace in ppm on a volume/volume basis ($ppm_{v/v}$). The detection limit of most OVMs is 1 $ppm_{v/v}$. Using the multiplication factor of 100 developed in Vonder Haar et al. (1989), 0.1 mg/kg of TCE in the drilling waste should be equivalent to about 10 $ppm_{v/v}$ in the headspace. Results show good correlation between the two methods.

Screening criteria are utilized to ensure no waste is deposited upon the ground or into pits that exceed disposal criteria. Drilling waste with headspace concentrations below 1,000 $ppm_{v/v}$, as measured by the OVM, should not exceed the disposal criteria of 10 mg/kg in the waste.

A. Disposal Criteria

1. Drilling waste <10 mg/kg total VOCs:

   Drill cuttings may be disposed of at the ground surface near the well site, reused as fill, or in the designated disposal area. If cuttings are disposed of near the well site, cuttings should be spread out as much as is practical. Drill cuttings may also be disposed of in the appropriate designated disposal area at the Livermore Site or Site 300. Drilling mud may be discharged to a pit or sump with a minimum of 2 ft of freeboard (Site 300) and 1 ft of freeboard (Livermore Site). For off-site drilling activities, drill cuttings and mud must be brought on site for disposal in the designated areas as determined by the appropriate EA and FC.

2. Drilling waste >10 mg/kg total VOCs:

   Drill cuttings may be temporarily placed on plastic sheeting at well site or Corp. Yard in a 6-in. lift to promote aeration and reduce VOC concentrations. Drilling mud must be either discharged directly to drums, or temporarily left in mud tank or trailer. After drilling at a location has been completed, the spoils should be re-evaluated for VOC concentration. If concentrations remain above 10 mg/kg, dispose of the waste appropriately as determined by HWM, in consultation with the appropriate EA.

6.8.2 Total Petroleum Hydrocarbons (TPH), Gasoline or Diesel Product Investigations

The Leaking Underground Fuel Tank (LUFT), Field Manual (State of California Leaking Underground Fuel Tank Task Force, 1988) sets a TPH concentration of 1,000 mg/kg in soil as a hazardous waste classification criterion and suggests that a lower value may be necessary on a case-by-case basis. The Bay Area Air Quality Management District (BAAQMD), San Joaquin County Air Pollution Control District (SJCAPCD), and Alameda County define TPH-contaminated soil as a soil that exhibits 50 mg/kg by weight TPH, but they exempt soil that is removed for sampling purposes (409.9 SJCAPCD; and 8-40-112 and 8-40-205 BAAQMD).

A. Disposal Criteria

1. Drilling waste <100 mg/kg TPH (equivalent to 10,000 $ppm_{v/v}$ on the OVM):

   Drill cuttings may be disposed of at the ground surface near the well site, reused as fill, or in the designated disposal area. If cuttings are disposed of near the well site, cuttings should be spread out as much as is practical. Drill cuttings may also be disposed of in the appropriate designated disposal area at Site 300 or the Livermore Site. Drilling mud may be discharged to a pit or sump with a minimum of 2 ft of freeboard (Site 300) and 1 ft of freeboard (Livermore Site). For off-site drilling activities, drill cuttings and mud must be brought on site for disposal in the designated areas as determined by the appropriate EA and FC.

2. Drilling waste >100 mg/kg TPH:

   Store drilling waste on site covered with plastic sheeting or in drums until a determination on the feasibility of enhanced soil bioremediation

(ESB) is made. If ESB is to be used, transport the waste to the ESB site. If ESB is not feasible, treat and/or dispose of the waste appropriately as determined by HWM, in consultation with the appropriate EA.

B. Bioremediation

Enhanced soil bioremediation (ESB) may be performed on drilling waste contaminated with only TPH. The soil is spread to a thickness of 6 to 12 in. Weekly watering and biweekly tilling stimulates indigenous microorganisms to utilize any hydrocarbons present as a fuel source, thereby reducing soil hydrocarbon concentrations. Fertilizer is added as necessary. Details on the ESB can be found in Carlsen (1991).

6.8.3 Metals Investigations

A. Disposal Criteria

l. Drilling waste below Soluble Threshold Limit Concentrations (STLCs):

Drill cuttings may be disposed of at the ground surface near the well site, reused as fill, or in the designated disposal area. If cuttings are disposed of near the well site, cuttings should be spread out as much as is practical. Drill cuttings may also be disposed of in the appropriate designated disposal area at Site 300 or the Livermore Site. Drilling mud may be discharged to a pit or sump with a minimum of 2 ft of freeboard (Site 300) and 1 ft of freeboard (Livermore Site). For off-site drilling activities, drill cuttings and mud must be brought on site for disposal in the designated areas as determined by the appropriate EA and FC.

2. Drilling waste above STLCs:

Dispose off site as hazardous waste through HWM.

6.8.4 Radiological Investigations

A. Tritium

At present, no Federal or State hazardous waste guidelines exist for tritium in soil. The most pertinent guideline is the classification threshold for tritium concentration as a Class A solid waste at 40.0 curies per cubic meter (10 CFR, Section 61.55). This value is approximately equivalent to 40,000 microcuries per liter (mCi/L) or 40,000,000,000 picocuries per liter (pCi/L). Tritium should be analyzed by either LLNL Environmental Sciences or a contract analytical laboratory using the “Soil Water Distillation” technique (detection limit is between 200 to 1,000 pCi/L or 0.02 to 0.1 picocuries per gram [pCi/g] at 10% moisture) or the “Beta Scan” technique (detection limit is approximately 10,000 pCi/L or 1.0 pCi/g at 10% moisture).

1. Disposal Criteria

a. Drilling waste below “Beta Scan” Practical Quantitation Limit (PQL); 1 pCi/g or a Lab counting of <5 pCi/g:

Drill cuttings may be disposed of at the ground surface near the well site, reused as fill, or in the designated disposal area. If cuttings are disposed of near the well site, cuttings should be spread out as much as is practical. Drill cuttings may also be disposed of in the appropriate designated disposal area at Site 300 or the Livermore Site. Drilling mud may be discharged to a pit or sump with a minimum of 2 ft of freeboard (Site 300) and 1 ft of freeboard (Livermore Site). For off-site drilling activities, drill cuttings and mud must be brought on site for disposal in the designated areas as determined by the appropriate EA and FC.

b. Drilling waste above "Beta Scan" PQL or a Lab counting of >5 and <60 pCi/g:

If tritium contamination is known or expected to be encountered within a particular zone, the spoils should be segregated as described in Section 6.6, to minimize the quantity of spoils that will need treatment or disposal.

c. Drilling waste results >60 pCi/g:

Dispose of mud or cuttings as radioactive waste determined on a case-by-case basis by the ECBGL in consultation with HWM and the appropriate EA, in accordance with applicable ARARs.

B. Other Radionuclides

The analytical results from the samples taken when the screening method detected activity twice the background level, shall be provided to the LLNL HWM Division and the appropriate EA to determine the appropriate method of waste disposal.

Drilling mud and cuttings are considered to have no LLNL-added radioactivity if the alpha activity is below 15 pCi/g soil and the beta activity is below 25 pCi/g, and drill cuttings may be disposed of at the ground surface near the well site, reused as fill, or in the designated disposal area. If cuttings are disposed of near the well site, cuttings should be spread out as much as is practical. Drill cuttings may also be disposed of in the appropriate designated disposal area at Site 300 or the Livermore Site. Drilling mud may be discharged to a pit or sump with a minimum of 2 ft of freeboard (Site 300) and 1 ft of freeboard (Livermore Site). For off-site drilling activities, drill cuttings and mud must be brought on site for disposal in the designated areas as determined by the appropriate EA. For soils that exceed these limits of gross alpha or beta, the soil should be treated as radioactive waste.

6.8.5 High Explosives (HE) Investigations of Cyclotetramethylene-Tetranitramine (HMX) and Cyclotrimethylene-Trinitramine (RDX)—Relevant only for Site 300.

There are no Federal or State criteria for establishing hazardous concentrations of HE compounds in soil. However, using the *Designated Level Methodology for Waste Classification and Cleanup Determination* (Marshack, 1989), LLNL Site 300 has established Designated Levels (DLs) for HMX and RDX. The DLs are the concentrations above which a soil may result in degradation of underlying ground water quality. The disposal criteria used are based upon a toxicological literature review presented in Crow and Lamarre (1990).

A. Disposal Criteria

1. Drilling waste <31.5 ppm RDX and <315.0 ppm HMX:

   Dispose of mud, cuttings, and unused core samples on ground surface at well site.

2. Drilling waste >31.5 ppm RDX and/or >315.0 ppm HMX:

   Treat or dispose of waste appropriately as determined by HWM and the appropriate Site 300 EA.

6.8.6 Other Detectable Contaminants or Multiple Contaminants

Discuss with the FC, HGL, and/or ECBGL.

6.9 Site Restoration/Post Operation

6.9.1 As soon as drilling and, if applicable, well installation has been completed, work should be done to restore the area to predrilling conditions.

6.9.2 Drill cuttings and unused soil core left at the well site should be tilled in with the native topsoil so that the nutrients and seed bank within the topsoil is introduced to the cuttings. The site should return to predrilling appearance after the vegetation has been reestablished.

6.9.3 In order to facilitate the restoration of drill sites where drilling mud will be disposed of in pits, the following steps should be taken:

A. Prior to excavating the pit, scrape off the top 1 to 2 ft of soil and save for restoration phase.

B. Install an animal escape ramp into pit as soon as it is excavated. The ramp should be repositioned each evening to ensure an adequate escape route. Place a barrier around the pit to prevent any animals or people from inadvertently walking into the pit.

C. Leave a minimum of 2 ft of freeboard in the pit after depositing the drilling mud. The pit should be filled as soon as possible to minimize the amount of time the excavation is open.

D. Allow a sufficient amount of time for the drilling mud to solidify (one to many months), depending on the season and amount of precipitation.

E. After drilling mud has solidified, cover the hardened mud with the topsoil that was removed prior to excavation. The site should return to predrilling appearance after the vegetation has been re-established.

6.10 Procedure Exceptions

In developing this SOP, every effort was made to ensure compliance with all ARARs, as required in EPA, 1991. But as recognized in EPA, 1991, it is often necessary to use the best professional judgment, in light of site-specific conditions. Thus, the DS after consultation with the ECBGL, and the FC, has the option to grant exceptions to the above drilling-waste management protocol. All exceptions will be granted only after consultation with project geologists, appropriate regulatory agencies, and other

appropriate professionals. Exceptions shall be granted only after the ECBGL determines that such actions are still protective of human health and the environment.

7.0 QUALITY ASSURANCE RECORDS

7.1 Borehole/Well Construction Log

7.2 Document Control Logbook

8.0 ATTACHMENTS

Attachment A—Site 300 ARARs

Attachment B—Livermore Site ARARs

Attachment A

Potential Federal, State, and Local ARARs Table

Attachment A. Potential Federal, State, and local ARARs.

ARAR	Comments	LLNL actions taken to comply with ARARs
Federal		
1. Clean Air Act (CAA) [42 USCA 7401–7642] [40 CFR 50–69]	**National primary and secondary ambient air quality standards (NAAQS) are defined under Section 109 of the CAA and are listed in 40 CFR 50.**	**Soils do not contain contaminants regulated under NAAQS.**
2. Clean Air Act [42 USCA 7412] [40 CFR 61.92]	**National Emission Standards for Hazardous Air Pollutants (NESHAPs) are specific to industrial emissions. 40 CFR 61.92 limits emissions of radionuclides to those amounts that would cause any member of the public to receive, in any one year, a maximum effective dose equivalent of 10 millirems per year (mrem/y).**	**Aeration of tritiated soils does not exceed dose limits.**
3. Land Disposal Restrictions (LDRs) RCRA [40 CFR 268]	**Any waste placed in land-disposal units must comply with LDRs by either attaining specific performance or technology-based standards.**	**Aeration of contaminated soils near boring in area of contamination is not considered "placement" under LDR restrictions, and is consistent with final site remedy.**
State		
4. Hazardous Waste Control Act (Health and Safety Code, Section 25100–25395), CCR, Title 22, ch. 30: Minimum Standards for Management of Hazardous and Extremely Hazardous Wastes	**HCWA controls hazardous wastes from their point of generation through accumulation, transportation, treatment, storage, and ultimate disposal. All potentially hazardous materials are handled in accordance with standard chain-of-custody procedures. These requirements are, therefore, applicable to all treatment alternatives.**	**All soil, other than VOC-containing soil, determined to be hazardous waste will be submitted to LLNL's Hazardous Waste Management Division for proper disposal following all applicable regulations. VOC-contaminated soil will be aerated in area of contamination.**
Criteria for Identifying Hazardous Wastes [Title 22, 66693–66776]	**Tests for identifying hazardous characteristics are set forth in these regulations.**	**All soil, other than VOC-containing soil, determined to be hazardous waste will be submitted to LLNL's Hazardous Waste Management Division for proper disposal following all applicable regulations. VOC-contaminated soil <10 ppm will be aerated in area of contamination.**

Table A-1. (Continued)

ARAR	Comments	LLNL actions taken to comply with ARARs
Persistent and Bioaccumulative Toxic Substances [Title 22, 66699]	**Total Threshold Limit Concentrations (TTLCs) and Soluble Threshold Limit Concentrations (STLCs) have been established for selected toxics to be used in establishing whether waste is hazardous. If a chemical is either listed or tested and found hazardous, then remedial actions must comply with the hazardous waste requirements under Title 22.**	**All soil, other than VOC-containing soil, determined to be hazardous waste will be submitted to LLNL's Hazardous Waste Management Division for proper disposal following all applicable regulations. VOC-contaminated soil <20 ppm will be aerated in area of contamination.**
5. Porter-Cologne Water Quality Control Act [WC13000–13806], as administered by the State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Board (RWQCB) under CCR Title 23, subch. 15, 1050–2836.	**Establishes authority for State and Regional Water Boards to determine site-specific discharge requirements and to regulate disposal of waste to land (see Table 3-2).**	**Aeration of contaminated soils comply with substantive sections of these regulations due to low volume of contaminants.**
6. Fish and Game Regulations on Pollution	**Prohibits water pollution with any substance or material deleterious to fish, plant, or bird life.**	**Aeration of contaminated soils in area of contamination will not result in water pollution deleterious to biota.**
7. Air Resources Act (Health and Safety Code, section 3900 et. seq.)	**Establishes allowable discharge standards for point sources within each air pollution control district, and establishes ambient air quality standards.**	**Aeration of contaminated soils comply with substantive sections of these regulations due to low volume of contaminants.**
8. Bay Area Air Quality Management District (8-40-112; 8-40-205) San Joaquin County Air Pollution Control District (409.9)	**Requires permitting of VOC air discharges (e.g., from an air-stripping unit).**	**Soil that is removed for sampling purposes is exempt.**
9. Central Valley Regional Water Quality Control Board Designated Level Methodology	**Provides guidance in establishing acceptable levels of soil contamination which will not impact ground or surface waters.**	**Methodology used to establish RDX and HMX designated levels.**